

```

> A<-rep(c(rep(c(-1),times=8),rep(c(1),times=8))),times=32)
> B<-rep(rep(c(rep(c(-1),times=4),rep(c(1),times=4))),times=2),times=32)
> C<-rep(rep(rep(c(-1,-1,1,1),times=2),times=2),times=32)
> D<-rep(rep(rep(c(-1,1),times=4),times=2),times=32)
> level.design<-data.frame(A=factor(A),B=factor(B),C=factor(C),D=factor(D))
> level.design

```

|    | A  | B  | C  | D  |
|----|----|----|----|----|
| 1  | -1 | -1 | -1 | -1 |
| 2  | -1 | -1 | -1 | 1  |
| 3  | -1 | -1 | 1  | -1 |
| 4  | -1 | -1 | 1  | 1  |
| 5  | -1 | 1  | -1 | -1 |
| 6  | -1 | 1  | -1 | 1  |
| 7  | -1 | 1  | 1  | -1 |
| 8  | -1 | 1  | 1  | 1  |
| 9  | 1  | -1 | -1 | -1 |
| 10 | 1  | -1 | -1 | 1  |
| 11 | 1  | -1 | 1  | -1 |
| 12 | 1  | -1 | 1  | 1  |
| 13 | 1  | 1  | -1 | -1 |
| 14 | 1  | 1  | -1 | 1  |
| 15 | 1  | 1  | 1  | -1 |
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> Percent.sugar<-rep(c(rep(c(6),times=8),rep(c(15),times=8)),times=32)  
 > Ratio.yoghurt<-rep(rep(c(rep(c(7.2),times=4),rep(c(36.5),times=4))),times=2),times=32)  
 > Percent.kiwi<-rep(rep(rep(c(8,8,15,15),times=2),times=2),times=32)  
 > Percent.water<-rep(rep(rep(c(13,34),times=4),times=2),times=32)  
 > R1<-c(6,7,5,5,5,4,6,6,4,7,4,8,2,3,6,6)  
 > R2<-c(3,8,4,6,3,6,6,7,3,4,3,4,3,8,8,2)  
 > R3<-c(7,8,6,8,7,6,5,8,7,9,7,9,4,9,8,8)  
 > R4<-c(5,5,6,6,3,4,8,5,4,8,5,8,5,9,5,6)  
 > R5<-c(7,8,5,6,6,8,6,5,8,8,6,7,5,8,5,6)

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> R6<-c(6,4,6,7,4,5,5,6,5,7,4,4,5,6,4,5)
> R7<-c(8,9,8,8,8,9,8,8,7,9,8,8,7,9,8,9)
> R8<-c(9,9,8,6,6,7,5,4,7,9,8,6,5,7,5,4)
> R9<-c(5,5,7,7,4,6,3,5,5,6,6,7,4,5,5,4)
> R10<-c(7,6,6,6,5,5,4,6,6,6,6,5,5,7,5,4)
> R11<-c(7,9,7,8,5,6,5,6,7,8,5,8,5,7,5,5)
> R12<-c(7,5,6,7,4,8,6,7,5,6,4,3,5,4,4,2)
> R13<-c(8,7,7,7,5,7,6,6,8,7,7,6,6,7,5,7)
> R14<-c(7,4,4,4,2,7,1,5,7,5,6,6,2,1,2,3)
> R15<-c(5,6,4,6,6,6,5,8,5,7,5,4,3,5,5,6)
> R16<-c(9,8,9,9,8,8,8,9,9,9,8,8,8,9,7,8)
> R17<-c(8,5,5,3,8,8,2,8,7,6,4,8,7,8,7,8)
> R18<-c(7,5,4,3,3,6,2,2,4,3,4,5,2,5,5,3)
> R19<-c(7,8,4,8,5,8,5,9,5,9,4,8,3,7,4,7)
> R20<-c(6,6,5,7,5,7,4,6,5,7,5,6,6,6,4,6)
> R21<-c(7,7,5,5,4,6,5,3,7,7,5,6,4,6,7,3)
> R22<-c(4,7,7,6,3,8,6,4,8,5,4,4,2,8,2,7)
> R23<-c(9,7,4,6,4,8,8,5,8,7,8,7,8,8,6,8)
> R24<-c(7,4,6,4,6,4,6,6,8,4,6,4,6,4,1,4)
> R25<-c(5,7,9,9,2,4,3,6,8,7,4,8,3,7,3,6)
> R26<-c(8,7,8,6,7,7,6,6,6,7,5,7,4,7,5,7)
> R27<-c(6,9,3,6,5,9,6,8,4,7,5,8,7,9,4,7)
> R28<-c(6,7,6,5,5,6,5,7,7,7,5,7,6,6,5,6)
> R29<-c(5,7,5,7,5,5,5,6,7,6,4,5,3,6,5,5)
> R30<-c(3,5,3,4,7,6,6,6,4,7,4,6,6,7,4,6)
> R31<-c(8,9,5,8,5,6,8,9,5,8,4,8,6,9,6,7)
> R32<-c(4,8,5,7,5,8,6,7,6,9,3,9,1,9,4,4)
>
response<-c(R1,R2,R3,R4,R5,R6,R7,R8,R9,R10,R11,R12,R13,R14,R15,R16,R17,R18,R19,R20,R21,R
22,R23,R24,R25,R26,R27,R28,R29,R30,R31,R32)
>
design<-data.frame(Percent.sugar=factor(Percent.sugar),Ratio.yoghurt=factor(Ratio.yoghurt),Perc
ent.kiwi=factor(Percent.kiwi),Percent.water=factor(Percent.water),response)
> design

```

|   | Percent.sugar | Ratio.yoghurt | Percent.kiwi | Percent.water | response |
|---|---------------|---------------|--------------|---------------|----------|
| 1 | 6             | 7.2           | 8            | 13            | 6        |
| 2 | 6             | 7.2           | 8            | 34            | 7        |
| 3 | 6             | 7.2           | 15           | 13            | 5        |
| 4 | 6             | 7.2           | 15           | 34            | 5        |
| 5 | 6             | 36.5          | 8            | 13            | 5        |
| 6 | 6             | 36.5          | 8            | 34            | 4        |
| 7 | 6             | 36.5          | 15           | 13            | 6        |
| 8 | 6             | 36.5          | 15           | 34            | 6        |
| 9 | 15            | 7.2           | 8            | 13            | 4        |

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|----|----|------|----|----|---|
| 10 | 15 | 7.2  | 8  | 34 | 7 |
| 11 | 15 | 7.2  | 15 | 13 | 4 |
| 12 | 15 | 7.2  | 15 | 34 | 8 |
| 13 | 15 | 36.5 | 8  | 13 | 2 |
| 14 | 15 | 36.5 | 8  | 34 | 3 |
| 15 | 15 | 36.5 | 15 | 13 | 6 |
| 16 | 15 | 36.5 | 15 | 34 | 6 |
| 17 | 6  | 7.2  | 8  | 13 | 3 |
| 18 | 6  | 7.2  | 8  | 34 | 8 |
| 19 | 6  | 7.2  | 15 | 13 | 4 |
| 20 | 6  | 7.2  | 15 | 34 | 6 |
| 21 | 6  | 36.5 | 8  | 13 | 3 |
| 22 | 6  | 36.5 | 8  | 34 | 6 |
| 23 | 6  | 36.5 | 15 | 13 | 6 |
| 24 | 6  | 36.5 | 15 | 34 | 7 |
| 25 | 15 | 7.2  | 8  | 13 | 3 |
| 26 | 15 | 7.2  | 8  | 34 | 4 |
| 27 | 15 | 7.2  | 15 | 13 | 3 |
| 28 | 15 | 7.2  | 15 | 34 | 4 |
| 29 | 15 | 36.5 | 8  | 13 | 3 |
| 30 | 15 | 36.5 | 8  | 34 | 8 |
| 31 | 15 | 36.5 | 15 | 13 | 8 |
| 32 | 15 | 36.5 | 15 | 34 | 2 |
| 33 | 6  | 7.2  | 8  | 13 | 7 |
| 34 | 6  | 7.2  | 8  | 34 | 8 |
| 35 | 6  | 7.2  | 15 | 13 | 6 |
| 36 | 6  | 7.2  | 15 | 34 | 8 |
| 37 | 6  | 36.5 | 8  | 13 | 7 |
| 38 | 6  | 36.5 | 8  | 34 | 6 |
| 39 | 6  | 36.5 | 15 | 13 | 5 |
| 40 | 6  | 36.5 | 15 | 34 | 8 |
| 41 | 15 | 7.2  | 8  | 13 | 7 |
| 42 | 15 | 7.2  | 8  | 34 | 9 |
| 43 | 15 | 7.2  | 15 | 13 | 7 |
| 44 | 15 | 7.2  | 15 | 34 | 9 |
| 45 | 15 | 36.5 | 8  | 13 | 4 |
| 46 | 15 | 36.5 | 8  | 34 | 9 |
| 47 | 15 | 36.5 | 15 | 13 | 8 |
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| 470 | 6  | 36.5 | 8  | 34 | 6 |
| 471 | 6  | 36.5 | 15 | 13 | 6 |
| 472 | 6  | 36.5 | 15 | 34 | 6 |
| 473 | 15 | 7.2  | 8  | 13 | 4 |
| 474 | 15 | 7.2  | 8  | 34 | 7 |
| 475 | 15 | 7.2  | 15 | 13 | 4 |
| 476 | 15 | 7.2  | 15 | 34 | 6 |
| 477 | 15 | 36.5 | 8  | 13 | 6 |
| 478 | 15 | 36.5 | 8  | 34 | 7 |
| 479 | 15 | 36.5 | 15 | 13 | 4 |
| 480 | 15 | 36.5 | 15 | 34 | 6 |
| 481 | 6  | 7.2  | 8  | 13 | 8 |
| 482 | 6  | 7.2  | 8  | 34 | 9 |
| 483 | 6  | 7.2  | 15 | 13 | 5 |
| 484 | 6  | 7.2  | 15 | 34 | 8 |
| 485 | 6  | 36.5 | 8  | 13 | 5 |
| 486 | 6  | 36.5 | 8  | 34 | 6 |
| 487 | 6  | 36.5 | 15 | 13 | 8 |
| 488 | 6  | 36.5 | 15 | 34 | 9 |
| 489 | 15 | 7.2  | 8  | 13 | 5 |
| 490 | 15 | 7.2  | 8  | 34 | 8 |
| 491 | 15 | 7.2  | 15 | 13 | 4 |
| 492 | 15 | 7.2  | 15 | 34 | 8 |
| 493 | 15 | 36.5 | 8  | 13 | 6 |



|     |    |      |    |    |   |
|-----|----|------|----|----|---|
| 494 | 15 | 36.5 | 8  | 34 | 9 |
| 495 | 15 | 36.5 | 15 | 13 | 6 |
| 496 | 15 | 36.5 | 15 | 34 | 7 |
| 497 | 6  | 7.2  | 8  | 13 | 4 |
| 498 | 6  | 7.2  | 8  | 34 | 8 |
| 499 | 6  | 7.2  | 15 | 13 | 5 |
| 500 | 6  | 7.2  | 15 | 34 | 7 |
| 501 | 6  | 36.5 | 8  | 13 | 5 |
| 502 | 6  | 36.5 | 8  | 34 | 8 |
| 503 | 6  | 36.5 | 15 | 13 | 6 |
| 504 | 6  | 36.5 | 15 | 34 | 7 |
| 505 | 15 | 7.2  | 8  | 13 | 6 |
| 506 | 15 | 7.2  | 8  | 34 | 9 |
| 507 | 15 | 7.2  | 15 | 13 | 3 |
| 508 | 15 | 7.2  | 15 | 34 | 9 |
| 509 | 15 | 36.5 | 8  | 13 | 1 |
| 510 | 15 | 36.5 | 8  | 34 | 9 |
| 511 | 15 | 36.5 | 15 | 13 | 4 |
| 512 | 15 | 36.5 | 15 | 34 | 4 |

```
>design.aov<-aov(response~Percent.sugar*Ratio.yoghurt*Percent.kiwi*Percent.water,data=design)
```

```
> summary(design.aov)
```

|  | Df      | Sum Sq        | Mean Sq |
|--|---------|---------------|---------|
| Percent.sugar  | 1       | 4.69          | 4.689   |
| Ratio.yoghurt  | 1       | 46.92         | 46.924  |
| Percent.kiwi   | 1       | 23.21         | 23.205  |
| Percent.water  | 1       | 131.02        | 131.018 |
| Percent.sugar:Ratio.yoghurt                            | 1       | 0.86          | 0.861   |
| Percent.sugar:Percent.kiwi                             | 1       | 1.88          | 1.877   |
| Ratio.yoghurt:Percent.kiwi                             | 1       | 6.80          | 6.799   |
| Percent.sugar:Percent.water                            | 1       | 4.69          | 4.689   |
| Ratio.yoghurt:Percent.water                            | 1       | 9.85          | 9.846   |
| Percent.kiwi:Percent.water                             | 1       | 3.61          | 3.611   |
| Percent.sugar:Ratio.yoghurt:Percent.kiwi               | 1       | 1.03          | 1.033   |
| Percent.sugar:Ratio.yoghurt:Percent.water              | 1       | 1.42          | 1.424   |
| Percent.sugar:Percent.kiwi:Percent.water               | 1       | 0.86          | 0.861   |
| Ratio.yoghurt:Percent.kiwi:Percent.water               | 1       | 16.17         | 16.174  |
| Percent.sugar:Ratio.yoghurt:Percent.kiwi:Percent.water | 1       | 2.67          | 2.674   |
| Residuals  | 496     | 1376.34       | 2.775   |
|  | F value | Pr(>F)        |         |
| Percent.sugar  | 1.6900  | 0.194210      |         |
| Ratio.yoghurt  | 16.9102 | 4.587e-05 *** |         |
| Percent.kiwi   | 8.3625  | 0.003999 **   |         |
| Percent.water  | 47.2155 | 1.915e-11 *** |         |

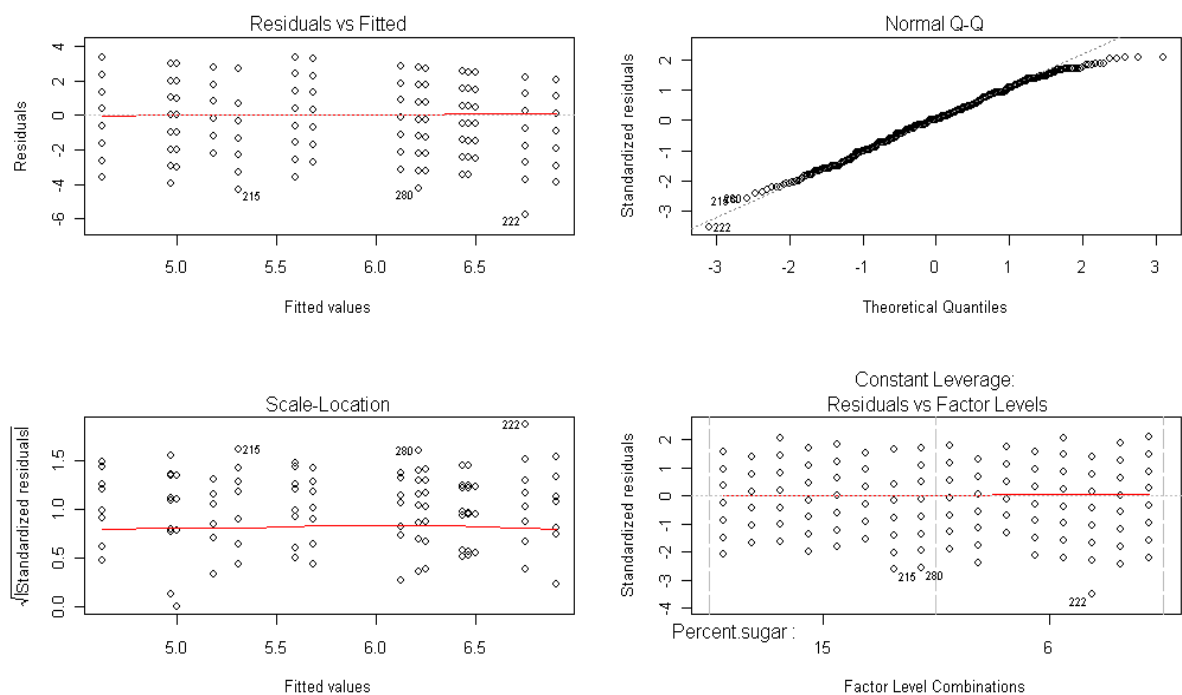
|  |        |            |
|--|--------|------------|
| Percent.sugar:Ratio.yoghurt                            | 0.3104 | 0.577685   |
| Percent.sugar:Percent.kiwi                             | 0.6764 | 0.411222   |
| Ratio.yoghurt:Percent.kiwi                             | 2.4501 | 0.118153   |
| Percent.sugar:Percent.water                            | 1.6900 | 0.194210   |
| Ratio.yoghurt:Percent.water                            | 3.5481 | 0.060197   |
| Percent.kiwi:Percent.water                             | 1.3014 | 0.254502   |
| Percent.sugar:Ratio.yoghurt:Percent.kiwi               | 0.3723 | 0.542011   |
| Percent.sugar:Ratio.yoghurt:Percent.water              | 0.5131 | 0.474132   |
| Percent.sugar:Percent.kiwi:Percent.water               | 0.3104 | 0.577685   |
| Ratio.yoghurt:Percent.kiwi:Percent.water               | 5.8286 | 0.016128 * |
| Percent.sugar:Ratio.yoghurt:Percent.kiwi:Percent.water | 0.9636 | 0.326765   |
| Residuals  |        |            |

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

```
> oldpar<-par(oma=c(0,0,3,0),mfrow=c(2,2))
> plot(design.aov)
> par(oldpar)
```

aov(response ~ Percent.sugar \* Ratio.yoghurt \* Percent.kiwi \* Percent.water ...



```
> library(rsm)
> design.rsm<-data.frame(Percent.sugar,Ratio.yoghurt,Percent.kiwi,Percent.water,response)
> design.CR<-coded.data(design.rsm,x1~(Percent.sugar-10.5)/4.5,x2~(Ratio.yoghurt-21.85)/14.65,
x3~(Percent.kiwi-11.5)/3.5,x4~(Percent.water-23.5)/10.5)
> design.CR
  x1 x2 x3 x4 response
1 -1 -1 -1 -1       6
```

|    |             |   |
|----|-------------|---|
| 2  | -1 -1 -1 1  | 7 |
| 3  | -1 -1 1 -1  | 5 |
| 4  | -1 -1 1 1   | 5 |
| 5  | -1 1 -1 -1  | 5 |
| 6  | -1 1 -1 1   | 4 |
| 7  | -1 1 1 -1   | 6 |
| 8  | -1 1 1 1    | 6 |
| 9  | 1 -1 -1 -1  | 4 |
| 10 | 1 -1 -1 1   | 7 |
| 11 | 1 -1 1 -1   | 4 |
| 12 | 1 -1 1 1    | 8 |
| 13 | 1 1 -1 -1   | 2 |
| 14 | 1 1 -1 1    | 3 |
| 15 | 1 1 1 -1    | 6 |
| 16 | 1 1 1 1     | 6 |
| 17 | -1 -1 -1 -1 | 3 |
| 18 | -1 -1 -1 1  | 8 |
| 19 | -1 -1 1 -1  | 4 |
| 20 | -1 -1 1 1   | 6 |
| 21 | -1 1 -1 -1  | 3 |
| 22 | -1 1 -1 1   | 6 |
| 23 | -1 1 1 -1   | 6 |
| 24 | -1 1 1 1    | 7 |
| 25 | 1 -1 -1 -1  | 3 |
| 26 | 1 -1 -1 1   | 4 |
| 27 | 1 -1 1 -1   | 3 |
| 28 | 1 -1 1 1    | 4 |
| 29 | 1 1 -1 -1   | 3 |
| 30 | 1 1 -1 1    | 8 |
| 31 | 1 1 1 -1    | 8 |
| 32 | 1 1 1 1     | 2 |
| 33 | -1 -1 -1 -1 | 7 |
| 34 | -1 -1 -1 1  | 8 |
| 35 | -1 -1 1 -1  | 6 |
| 36 | -1 -1 1 1   | 8 |
| 37 | -1 1 -1 -1  | 7 |
| 38 | -1 1 -1 1   | 6 |
| 39 | -1 1 1 -1   | 5 |
| 40 | -1 1 1 1    | 8 |
| 41 | 1 -1 -1 -1  | 7 |
| 42 | 1 -1 -1 1   | 9 |
| 43 | 1 -1 1 -1   | 7 |
| 44 | 1 -1 1 1    | 9 |
| 45 | 1 1 -1 -1   | 4 |

|    |    |    |    |    |   |
|----|----|----|----|----|---|
| 46 | 1  | 1  | -1 | 1  | 9 |
| 47 | 1  | 1  | 1  | -1 | 8 |
| 48 | 1  | 1  | 1  | 1  | 8 |
| 49 | -1 | -1 | -1 | -1 | 5 |
| 50 | -1 | -1 | -1 | 1  | 5 |
| 51 | -1 | -1 | 1  | -1 | 6 |
| 52 | -1 | -1 | 1  | 1  | 6 |
| 53 | -1 | 1  | -1 | -1 | 3 |
| 54 | -1 | 1  | -1 | 1  | 4 |
| 55 | -1 | 1  | 1  | -1 | 8 |
| 56 | -1 | 1  | 1  | 1  | 5 |
| 57 | 1  | -1 | -1 | -1 | 4 |
| 58 | 1  | -1 | -1 | 1  | 8 |
| 59 | 1  | -1 | 1  | -1 | 5 |
| 60 | 1  | -1 | 1  | 1  | 8 |
| 61 | 1  | 1  | -1 | -1 | 5 |
| 62 | 1  | 1  | -1 | 1  | 9 |
| 63 | 1  | 1  | 1  | -1 | 5 |
| 64 | 1  | 1  | 1  | 1  | 6 |
| 65 | -1 | -1 | -1 | -1 | 7 |
| 66 | -1 | -1 | -1 | 1  | 8 |
| 67 | -1 | -1 | 1  | -1 | 5 |
| 68 | -1 | -1 | 1  | 1  | 6 |
| 69 | -1 | 1  | -1 | -1 | 6 |
| 70 | -1 | 1  | -1 | 1  | 8 |
| 71 | -1 | 1  | 1  | -1 | 6 |
| 72 | -1 | 1  | 1  | 1  | 5 |
| 73 | 1  | -1 | -1 | -1 | 8 |
| 74 | 1  | -1 | -1 | 1  | 8 |
| 75 | 1  | -1 | 1  | -1 | 6 |
| 76 | 1  | -1 | 1  | 1  | 7 |
| 77 | 1  | 1  | -1 | -1 | 5 |
| 78 | 1  | 1  | -1 | 1  | 8 |
| 79 | 1  | 1  | 1  | -1 | 5 |
| 80 | 1  | 1  | 1  | 1  | 6 |
| 81 | -1 | -1 | -1 | -1 | 6 |
| 82 | -1 | -1 | -1 | 1  | 4 |
| 83 | -1 | -1 | 1  | -1 | 6 |
| 84 | -1 | -1 | 1  | 1  | 7 |
| 85 | -1 | 1  | -1 | -1 | 4 |
| 86 | -1 | 1  | -1 | 1  | 5 |
| 87 | -1 | 1  | 1  | -1 | 5 |
| 88 | -1 | 1  | 1  | 1  | 6 |
| 89 | 1  | -1 | -1 | -1 | 5 |

|     |             |   |
|-----|-------------|---|
| 90  | 1 -1 -1 1   | 7 |
| 91  | 1 -1 1 -1   | 4 |
| 92  | 1 -1 1 1    | 4 |
| 93  | 1 1 -1 -1   | 5 |
| 94  | 1 1 -1 1    | 6 |
| 95  | 1 1 1 -1    | 4 |
| 96  | 1 1 1 1     | 5 |
| 97  | -1 -1 -1 -1 | 8 |
| 98  | -1 -1 -1 1  | 9 |
| 99  | -1 -1 1 -1  | 8 |
| 100 | -1 -1 1 1   | 8 |
| 101 | -1 1 -1 -1  | 8 |
| 102 | -1 1 -1 1   | 9 |
| 103 | -1 1 1 -1   | 8 |
| 104 | -1 1 1 1    | 8 |
| 105 | 1 -1 -1 -1  | 7 |
| 106 | 1 -1 -1 1   | 9 |
| 107 | 1 -1 1 -1   | 8 |
| 108 | 1 -1 1 1    | 8 |
| 109 | 1 1 -1 -1   | 7 |
| 110 | 1 1 -1 1    | 9 |
| 111 | 1 1 1 -1    | 8 |
| 112 | 1 1 1 1     | 9 |
| 113 | -1 -1 -1 -1 | 9 |
| 114 | -1 -1 -1 1  | 9 |
| 115 | -1 -1 1 -1  | 8 |
| 116 | -1 -1 1 1   | 6 |
| 117 | -1 1 -1 -1  | 6 |
| 118 | -1 1 -1 1   | 7 |
| 119 | -1 1 1 -1   | 5 |
| 120 | -1 1 1 1    | 4 |
| 121 | 1 -1 -1 -1  | 7 |
| 122 | 1 -1 -1 1   | 9 |
| 123 | 1 -1 1 -1   | 8 |
| 124 | 1 -1 1 1    | 6 |
| 125 | 1 1 -1 -1   | 5 |
| 126 | 1 1 -1 1    | 7 |
| 127 | 1 1 1 -1    | 5 |
| 128 | 1 1 1 1     | 4 |
| 129 | -1 -1 -1 -1 | 5 |
| 130 | -1 -1 -1 1  | 5 |
| 131 | -1 -1 1 -1  | 7 |
| 132 | -1 -1 1 1   | 7 |
| 133 | -1 1 -1 -1  | 4 |

|     |    |    |    |    |   |
|-----|----|----|----|----|---|
| 134 | -1 | 1  | -1 | 1  | 6 |
| 135 | -1 | 1  | 1  | -1 | 3 |
| 136 | -1 | 1  | 1  | 1  | 5 |
| 137 | 1  | -1 | -1 | -1 | 5 |
| 138 | 1  | -1 | -1 | 1  | 6 |
| 139 | 1  | -1 | 1  | -1 | 6 |
| 140 | 1  | -1 | 1  | 1  | 7 |
| 141 | 1  | 1  | -1 | -1 | 4 |
| 142 | 1  | 1  | -1 | 1  | 5 |
| 143 | 1  | 1  | 1  | -1 | 5 |
| 144 | 1  | 1  | 1  | 1  | 4 |
| 145 | -1 | -1 | -1 | -1 | 7 |
| 146 | -1 | -1 | -1 | 1  | 6 |
| 147 | -1 | -1 | 1  | -1 | 6 |
| 148 | -1 | -1 | 1  | 1  | 6 |
| 149 | -1 | 1  | -1 | -1 | 5 |
| 150 | -1 | 1  | -1 | 1  | 5 |
| 151 | -1 | 1  | 1  | -1 | 4 |
| 152 | -1 | 1  | 1  | 1  | 6 |
| 153 | 1  | -1 | -1 | -1 | 6 |
| 154 | 1  | -1 | -1 | 1  | 6 |
| 155 | 1  | -1 | 1  | -1 | 6 |
| 156 | 1  | -1 | 1  | 1  | 5 |
| 157 | 1  | 1  | -1 | -1 | 5 |
| 158 | 1  | 1  | -1 | 1  | 7 |
| 159 | 1  | 1  | 1  | -1 | 5 |
| 160 | 1  | 1  | 1  | 1  | 4 |
| 161 | -1 | -1 | -1 | -1 | 7 |
| 162 | -1 | -1 | -1 | 1  | 9 |
| 163 | -1 | -1 | 1  | -1 | 7 |
| 164 | -1 | -1 | 1  | 1  | 8 |
| 165 | -1 | 1  | -1 | -1 | 5 |
| 166 | -1 | 1  | -1 | 1  | 6 |
| 167 | -1 | 1  | 1  | -1 | 5 |
| 168 | -1 | 1  | 1  | 1  | 6 |
| 169 | 1  | -1 | -1 | -1 | 7 |
| 170 | 1  | -1 | -1 | 1  | 8 |
| 171 | 1  | -1 | 1  | -1 | 5 |
| 172 | 1  | -1 | 1  | 1  | 8 |
| 173 | 1  | 1  | -1 | -1 | 5 |
| 174 | 1  | 1  | -1 | 1  | 7 |
| 175 | 1  | 1  | 1  | -1 | 5 |
| 176 | 1  | 1  | 1  | 1  | 5 |
| 177 | -1 | -1 | -1 | -1 | 7 |

|                 |   |
|-----------------|---|
| 178 -1 -1 -1 1  | 5 |
| 179 -1 -1 1 -1  | 6 |
| 180 -1 -1 1 1   | 7 |
| 181 -1 1 -1 -1  | 4 |
| 182 -1 1 -1 1   | 8 |
| 183 -1 1 1 -1   | 6 |
| 184 -1 1 1 1    | 7 |
| 185 1 -1 -1 -1  | 5 |
| 186 1 -1 -1 1   | 6 |
| 187 1 -1 1 -1   | 4 |
| 188 1 -1 1 1    | 3 |
| 189 1 1 -1 -1   | 5 |
| 190 1 1 -1 1    | 4 |
| 191 1 1 1 -1    | 4 |
| 192 1 1 1 1     | 2 |
| 193 -1 -1 -1 -1 | 8 |
| 194 -1 -1 -1 1  | 7 |
| 195 -1 -1 1 -1  | 7 |
| 196 -1 -1 1 1   | 7 |
| 197 -1 1 -1 -1  | 5 |
| 198 -1 1 -1 1   | 7 |
| 199 -1 1 1 -1   | 6 |
| 200 -1 1 1 1    | 6 |
| 201 1 -1 -1 -1  | 8 |
| 202 1 -1 -1 1   | 7 |
| 203 1 -1 1 -1   | 7 |
| 204 1 -1 1 1    | 6 |
| 205 1 1 -1 -1   | 6 |
| 206 1 1 -1 1    | 7 |
| 207 1 1 1 -1    | 5 |
| 208 1 1 1 1     | 7 |
| 209 -1 -1 -1 -1 | 7 |
| 210 -1 -1 -1 1  | 4 |
| 211 -1 -1 1 -1  | 4 |
| 212 -1 -1 1 1   | 4 |
| 213 -1 1 -1 -1  | 2 |
| 214 -1 1 -1 1   | 7 |
| 215 -1 1 1 -1   | 1 |
| 216 -1 1 1 1    | 5 |
| 217 1 -1 -1 -1  | 7 |
| 218 1 -1 -1 1   | 5 |
| 219 1 -1 1 -1   | 6 |
| 220 1 -1 1 1    | 6 |
| 221 1 1 -1 -1   | 2 |

|     |    |    |    |    |   |
|-----|----|----|----|----|---|
| 222 | 1  | 1  | -1 | 1  | 1 |
| 223 | 1  | 1  | 1  | -1 | 2 |
| 224 | 1  | 1  | 1  | 1  | 3 |
| 225 | -1 | -1 | -1 | -1 | 5 |
| 226 | -1 | -1 | -1 | 1  | 6 |
| 227 | -1 | -1 | 1  | -1 | 4 |
| 228 | -1 | -1 | 1  | 1  | 6 |
| 229 | -1 | 1  | -1 | -1 | 6 |
| 230 | -1 | 1  | -1 | 1  | 6 |
| 231 | -1 | 1  | 1  | -1 | 5 |
| 232 | -1 | 1  | 1  | 1  | 8 |
| 233 | 1  | -1 | -1 | -1 | 5 |
| 234 | 1  | -1 | -1 | 1  | 7 |
| 235 | 1  | -1 | 1  | -1 | 5 |
| 236 | 1  | -1 | 1  | 1  | 4 |
| 237 | 1  | 1  | -1 | -1 | 3 |
| 238 | 1  | 1  | -1 | 1  | 5 |
| 239 | 1  | 1  | 1  | -1 | 5 |
| 240 | 1  | 1  | 1  | 1  | 6 |
| 241 | -1 | -1 | -1 | -1 | 9 |
| 242 | -1 | -1 | -1 | 1  | 8 |
| 243 | -1 | -1 | 1  | -1 | 9 |
| 244 | -1 | -1 | 1  | 1  | 9 |
| 245 | -1 | 1  | -1 | -1 | 8 |
| 246 | -1 | 1  | -1 | 1  | 8 |
| 247 | -1 | 1  | 1  | -1 | 8 |
| 248 | -1 | 1  | 1  | 1  | 9 |
| 249 | 1  | -1 | -1 | -1 | 9 |
| 250 | 1  | -1 | -1 | 1  | 9 |
| 251 | 1  | -1 | 1  | -1 | 8 |
| 252 | 1  | -1 | 1  | 1  | 8 |
| 253 | 1  | 1  | -1 | -1 | 8 |
| 254 | 1  | 1  | -1 | 1  | 9 |
| 255 | 1  | 1  | 1  | -1 | 7 |
| 256 | 1  | 1  | 1  | 1  | 8 |
| 257 | -1 | -1 | -1 | -1 | 8 |
| 258 | -1 | -1 | -1 | 1  | 5 |
| 259 | -1 | -1 | 1  | -1 | 5 |
| 260 | -1 | -1 | 1  | 1  | 3 |
| 261 | -1 | 1  | -1 | -1 | 8 |
| 262 | -1 | 1  | -1 | 1  | 8 |
| 263 | -1 | 1  | 1  | -1 | 2 |
| 264 | -1 | 1  | 1  | 1  | 8 |
| 265 | 1  | -1 | -1 | -1 | 7 |



|     |             |   |
|-----|-------------|---|
| 266 | 1 -1 -1 1   | 6 |
| 267 | 1 -1 1 -1   | 4 |
| 268 | 1 -1 1 1    | 8 |
| 269 | 1 1 -1 -1   | 7 |
| 270 | 1 1 -1 1    | 8 |
| 271 | 1 1 1 -1    | 7 |
| 272 | 1 1 1 1     | 8 |
| 273 | -1 -1 -1 -1 | 7 |
| 274 | -1 -1 -1 1  | 5 |
| 275 | -1 -1 1 -1  | 4 |
| 276 | -1 -1 1 1   | 3 |
| 277 | -1 1 -1 -1  | 3 |
| 278 | -1 1 -1 1   | 6 |
| 279 | -1 1 1 -1   | 2 |
| 280 | -1 1 1 1    | 2 |
| 281 | 1 -1 -1 -1  | 4 |
| 282 | 1 -1 -1 1   | 3 |
| 283 | 1 -1 1 -1   | 4 |
| 284 | 1 -1 1 1    | 5 |
| 285 | 1 1 -1 -1   | 2 |
| 286 | 1 1 -1 1    | 5 |
| 287 | 1 1 1 -1    | 5 |
| 288 | 1 1 1 1     | 3 |
| 289 | -1 -1 -1 -1 | 7 |
| 290 | -1 -1 -1 1  | 8 |
| 291 | -1 -1 1 -1  | 4 |
| 292 | -1 -1 1 1   | 8 |
| 293 | -1 1 -1 -1  | 5 |
| 294 | -1 1 -1 1   | 8 |
| 295 | -1 1 1 -1   | 5 |
| 296 | -1 1 1 1    | 9 |
| 297 | 1 -1 -1 -1  | 5 |
| 298 | 1 -1 -1 1   | 9 |
| 299 | 1 -1 1 -1   | 4 |
| 300 | 1 -1 1 1    | 8 |
| 301 | 1 1 -1 -1   | 3 |
| 302 | 1 1 -1 1    | 7 |
| 303 | 1 1 1 -1    | 4 |
| 304 | 1 1 1 1     | 7 |
| 305 | -1 -1 -1 -1 | 6 |
| 306 | -1 -1 -1 1  | 6 |
| 307 | -1 -1 1 -1  | 5 |
| 308 | -1 -1 1 1   | 7 |
| 309 | -1 1 -1 -1  | 5 |

|     |    |    |    |    |   |
|-----|----|----|----|----|---|
| 310 | -1 | 1  | -1 | 1  | 7 |
| 311 | -1 | 1  | 1  | -1 | 4 |
| 312 | -1 | 1  | 1  | 1  | 6 |
| 313 | 1  | -1 | -1 | -1 | 5 |
| 314 | 1  | -1 | -1 | 1  | 7 |
| 315 | 1  | -1 | 1  | -1 | 5 |
| 316 | 1  | -1 | 1  | 1  | 6 |
| 317 | 1  | 1  | -1 | -1 | 6 |
| 318 | 1  | 1  | -1 | 1  | 6 |
| 319 | 1  | 1  | 1  | -1 | 4 |
| 320 | 1  | 1  | 1  | 1  | 6 |
| 321 | -1 | -1 | -1 | -1 | 7 |
| 322 | -1 | -1 | -1 | 1  | 7 |
| 323 | -1 | -1 | 1  | -1 | 5 |
| 324 | -1 | -1 | 1  | 1  | 5 |
| 325 | -1 | 1  | -1 | -1 | 4 |
| 326 | -1 | 1  | -1 | 1  | 6 |
| 327 | -1 | 1  | 1  | -1 | 5 |
| 328 | -1 | 1  | 1  | 1  | 3 |
| 329 | 1  | -1 | -1 | -1 | 7 |
| 330 | 1  | -1 | -1 | 1  | 7 |
| 331 | 1  | -1 | 1  | -1 | 5 |
| 332 | 1  | -1 | 1  | 1  | 6 |
| 333 | 1  | 1  | -1 | -1 | 4 |
| 334 | 1  | 1  | -1 | 1  | 6 |
| 335 | 1  | 1  | 1  | -1 | 7 |
| 336 | 1  | 1  | 1  | 1  | 3 |
| 337 | -1 | -1 | -1 | -1 | 4 |
| 338 | -1 | -1 | -1 | 1  | 7 |
| 339 | -1 | -1 | 1  | -1 | 7 |
| 340 | -1 | -1 | 1  | 1  | 6 |
| 341 | -1 | 1  | -1 | -1 | 3 |
| 342 | -1 | 1  | -1 | 1  | 8 |
| 343 | -1 | 1  | 1  | -1 | 6 |
| 344 | -1 | 1  | 1  | 1  | 4 |
| 345 | 1  | -1 | -1 | -1 | 8 |
| 346 | 1  | -1 | -1 | 1  | 5 |
| 347 | 1  | -1 | 1  | -1 | 4 |
| 348 | 1  | -1 | 1  | 1  | 4 |
| 349 | 1  | 1  | -1 | -1 | 2 |
| 350 | 1  | 1  | -1 | 1  | 8 |
| 351 | 1  | 1  | 1  | -1 | 2 |
| 352 | 1  | 1  | 1  | 1  | 7 |
| 353 | -1 | -1 | -1 | -1 | 9 |

|                 |   |
|-----------------|---|
| 354 -1 -1 -1 1  | 7 |
| 355 -1 -1 1 -1  | 4 |
| 356 -1 -1 1 1   | 6 |
| 357 -1 1 -1 -1  | 4 |
| 358 -1 1 -1 1   | 8 |
| 359 -1 1 1 -1   | 8 |
| 360 -1 1 1 1    | 5 |
| 361 1 -1 -1 -1  | 8 |
| 362 1 -1 -1 1   | 7 |
| 363 1 -1 1 -1   | 8 |
| 364 1 -1 1 1    | 7 |
| 365 1 1 -1 -1   | 8 |
| 366 1 1 -1 1    | 8 |
| 367 1 1 1 -1    | 6 |
| 368 1 1 1 1     | 8 |
| 369 -1 -1 -1 -1 | 7 |
| 370 -1 -1 -1 1  | 4 |
| 371 -1 -1 1 -1  | 6 |
| 372 -1 -1 1 1   | 4 |
| 373 -1 1 -1 -1  | 6 |
| 374 -1 1 -1 1   | 4 |
| 375 -1 1 1 -1   | 6 |
| 376 -1 1 1 1    | 6 |
| 377 1 -1 -1 -1  | 8 |
| 378 1 -1 -1 1   | 4 |
| 379 1 -1 1 -1   | 6 |
| 380 1 -1 1 1    | 4 |
| 381 1 1 -1 -1   | 6 |
| 382 1 1 -1 1    | 4 |
| 383 1 1 1 -1    | 1 |
| 384 1 1 1 1     | 4 |
| 385 -1 -1 -1 -1 | 5 |
| 386 -1 -1 -1 1  | 7 |
| 387 -1 -1 1 -1  | 9 |
| 388 -1 -1 1 1   | 9 |
| 389 -1 1 -1 -1  | 2 |
| 390 -1 1 -1 1   | 4 |
| 391 -1 1 1 -1   | 3 |
| 392 -1 1 1 1    | 6 |
| 393 1 -1 -1 -1  | 8 |
| 394 1 -1 -1 1   | 7 |
| 395 1 -1 1 -1   | 4 |
| 396 1 -1 1 1    | 8 |
| 397 1 1 -1 -1   | 3 |

|     |    |    |    |    |   |
|-----|----|----|----|----|---|
| 398 | 1  | 1  | -1 | 1  | 7 |
| 399 | 1  | 1  | 1  | -1 | 3 |
| 400 | 1  | 1  | 1  | 1  | 6 |
| 401 | -1 | -1 | -1 | -1 | 8 |
| 402 | -1 | -1 | -1 | 1  | 7 |
| 403 | -1 | -1 | 1  | -1 | 8 |
| 404 | -1 | -1 | 1  | 1  | 6 |
| 405 | -1 | 1  | -1 | -1 | 7 |
| 406 | -1 | 1  | -1 | 1  | 7 |
| 407 | -1 | 1  | 1  | -1 | 6 |
| 408 | -1 | 1  | 1  | 1  | 6 |
| 409 | 1  | -1 | -1 | -1 | 6 |
| 410 | 1  | -1 | -1 | 1  | 7 |
| 411 | 1  | -1 | 1  | -1 | 5 |
| 412 | 1  | -1 | 1  | 1  | 7 |
| 413 | 1  | 1  | -1 | -1 | 4 |
| 414 | 1  | 1  | -1 | 1  | 7 |
| 415 | 1  | 1  | 1  | -1 | 5 |
| 416 | 1  | 1  | 1  | 1  | 7 |
| 417 | -1 | -1 | -1 | -1 | 6 |
| 418 | -1 | -1 | -1 | 1  | 9 |
| 419 | -1 | -1 | 1  | -1 | 3 |
| 420 | -1 | -1 | 1  | 1  | 6 |
| 421 | -1 | 1  | -1 | -1 | 5 |
| 422 | -1 | 1  | -1 | 1  | 9 |
| 423 | -1 | 1  | 1  | -1 | 6 |
| 424 | -1 | 1  | 1  | 1  | 8 |
| 425 | 1  | -1 | -1 | -1 | 4 |
| 426 | 1  | -1 | -1 | 1  | 7 |
| 427 | 1  | -1 | 1  | -1 | 5 |
| 428 | 1  | -1 | 1  | 1  | 8 |
| 429 | 1  | 1  | -1 | -1 | 7 |
| 430 | 1  | 1  | -1 | 1  | 9 |
| 431 | 1  | 1  | 1  | -1 | 4 |
| 432 | 1  | 1  | 1  | 1  | 7 |
| 433 | -1 | -1 | -1 | -1 | 6 |
| 434 | -1 | -1 | -1 | 1  | 7 |
| 435 | -1 | -1 | 1  | -1 | 6 |
| 436 | -1 | -1 | 1  | 1  | 5 |
| 437 | -1 | 1  | -1 | -1 | 5 |
| 438 | -1 | 1  | -1 | 1  | 6 |
| 439 | -1 | 1  | 1  | -1 | 5 |
| 440 | -1 | 1  | 1  | 1  | 7 |
| 441 | 1  | -1 | -1 | -1 | 7 |

|     |    |    |    |    |   |
|-----|----|----|----|----|---|
| 442 | 1  | -1 | -1 | 1  | 7 |
| 443 | 1  | -1 | 1  | -1 | 5 |
| 444 | 1  | -1 | 1  | 1  | 7 |
| 445 | 1  | 1  | -1 | -1 | 6 |
| 446 | 1  | 1  | -1 | 1  | 6 |
| 447 | 1  | 1  | 1  | -1 | 5 |
| 448 | 1  | 1  | 1  | 1  | 6 |
| 449 | -1 | -1 | -1 | -1 | 5 |
| 450 | -1 | -1 | -1 | 1  | 7 |
| 451 | -1 | -1 | 1  | -1 | 5 |
| 452 | -1 | -1 | 1  | 1  | 7 |
| 453 | -1 | 1  | -1 | -1 | 5 |
| 454 | -1 | 1  | -1 | 1  | 5 |
| 455 | -1 | 1  | 1  | -1 | 5 |
| 456 | -1 | 1  | 1  | 1  | 6 |
| 457 | 1  | -1 | -1 | -1 | 7 |
| 458 | 1  | -1 | -1 | 1  | 6 |
| 459 | 1  | -1 | 1  | -1 | 4 |
| 460 | 1  | -1 | 1  | 1  | 5 |
| 461 | 1  | 1  | -1 | -1 | 3 |
| 462 | 1  | 1  | -1 | 1  | 6 |
| 463 | 1  | 1  | 1  | -1 | 5 |
| 464 | 1  | 1  | 1  | 1  | 5 |
| 465 | -1 | -1 | -1 | -1 | 3 |
| 466 | -1 | -1 | -1 | 1  | 5 |
| 467 | -1 | -1 | 1  | -1 | 3 |
| 468 | -1 | -1 | 1  | 1  | 4 |
| 469 | -1 | 1  | -1 | -1 | 7 |
| 470 | -1 | 1  | -1 | 1  | 6 |
| 471 | -1 | 1  | 1  | -1 | 6 |
| 472 | -1 | 1  | 1  | 1  | 6 |
| 473 | 1  | -1 | -1 | -1 | 4 |
| 474 | 1  | -1 | -1 | 1  | 7 |
| 475 | 1  | -1 | 1  | -1 | 4 |
| 476 | 1  | -1 | 1  | 1  | 6 |
| 477 | 1  | 1  | -1 | -1 | 6 |
| 478 | 1  | 1  | -1 | 1  | 7 |
| 479 | 1  | 1  | 1  | -1 | 4 |
| 480 | 1  | 1  | 1  | 1  | 6 |
| 481 | -1 | -1 | -1 | -1 | 8 |
| 482 | -1 | -1 | -1 | 1  | 9 |
| 483 | -1 | -1 | 1  | -1 | 5 |
| 484 | -1 | -1 | 1  | 1  | 8 |
| 485 | -1 | 1  | -1 | -1 | 5 |

|     |    |    |    |    |   |
|-----|----|----|----|----|---|
| 486 | -1 | 1  | -1 | 1  | 6 |
| 487 | -1 | 1  | 1  | -1 | 8 |
| 488 | -1 | 1  | 1  | 1  | 9 |
| 489 | 1  | -1 | -1 | -1 | 5 |
| 490 | 1  | -1 | -1 | 1  | 8 |
| 491 | 1  | -1 | 1  | -1 | 4 |
| 492 | 1  | -1 | 1  | 1  | 8 |
| 493 | 1  | 1  | -1 | -1 | 6 |
| 494 | 1  | 1  | -1 | 1  | 9 |
| 495 | 1  | 1  | 1  | -1 | 6 |
| 496 | 1  | 1  | 1  | 1  | 7 |
| 497 | -1 | -1 | -1 | -1 | 4 |
| 498 | -1 | -1 | -1 | 1  | 8 |
| 499 | -1 | -1 | 1  | -1 | 5 |
| 500 | -1 | -1 | 1  | 1  | 7 |
| 501 | -1 | 1  | -1 | -1 | 5 |
| 502 | -1 | 1  | -1 | 1  | 8 |
| 503 | -1 | 1  | 1  | -1 | 6 |
| 504 | -1 | 1  | 1  | 1  | 7 |
| 505 | 1  | -1 | -1 | -1 | 6 |
| 506 | 1  | -1 | -1 | 1  | 9 |
| 507 | 1  | -1 | 1  | -1 | 3 |
| 508 | 1  | -1 | 1  | 1  | 9 |
| 509 | 1  | 1  | -1 | -1 | 1 |
| 510 | 1  | 1  | -1 | 1  | 9 |
| 511 | 1  | 1  | 1  | -1 | 4 |
| 512 | 1  | 1  | 1  | 1  | 4 |

Variable codings ...

$x1 \sim (\text{Percent.sugar} - 10.5)/4.5$

$x2 \sim (\text{Ratio.yoghurt} - 21.85)/14.65$

$x3 \sim (\text{Percent.kiwi} - 11.5)/3.5$

$x4 \sim (\text{Percent.water} - 23.5)/10.5$

> `design.rs1<-rsm(response~FO(x1,x2,x3,x4)+TWI(x1,x2,x3,x4),data=design.CR)`

> `summary(design.rs1)`

Call:

`rsm(formula = response ~ FO(x1, x2, x3, x4) + TWI(x1, x2, x3, x4), data = design.CR)`

Residuals:

|  | Min     | 1Q      | Median  | 3Q     | Max    |
|--|---------|---------|---------|--------|--------|
|  | -5.4668 | -1.1621 | -0.0605 | 1.0957 | 3.3301 |

Coefficients:

|             | Estimate | Std. Error | t value | Pr(> t )     |
|-------------|----------|------------|---------|--------------|
| (Intercept) | 5.92383  | 0.07384    | 80.228  | < 2e-16 ***  |
| x1          | -0.09570 | 0.07384    | -1.296  | 0.19553      |
| x2          | -0.30273 | 0.07384    | -4.100  | 4.82e-05 *** |
| x3          | -0.21289 | 0.07384    | -2.883  | 0.00411 **   |
| x4          | 0.50586  | 0.07384    | 6.851   | 2.16e-11 *** |
| x1:x2       | -0.04102 | 0.07384    | -0.555  | 0.57881      |
| x1:x3       | -0.06055 | 0.07384    | -0.820  | 0.41261      |
| x1:x4       | 0.09570  | 0.07384    | 1.296   | 0.19553      |
| x2:x3       | 0.11523  | 0.07384    | 1.561   | 0.11924      |
| x2:x4       | 0.13867  | 0.07384    | 1.878   | 0.06095 .    |
| x3:x4       | -0.08398 | 0.07384    | -1.137  | 0.25591      |

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.671 on 501 degrees of freedom

Multiple R-squared: 0.1431, Adjusted R-squared: 0.126

F-statistic: 8.366 on 10 and 501 DF, p-value: 1.253e-12

Analysis of Variance Table

Response: response

|                     | Df  | Sum Sq  | Mean Sq | F value | Pr(>F)    |
|---------------------|-----|---------|---------|---------|-----------|
| FO(x1, x2, x3, x4)  | 4   | 205.84  | 51.459  | 18.4346 | 3.823e-14 |
| TWI(x1, x2, x3, x4) | 6   | 27.68   | 4.614   | 1.6529  | 0.1307    |
| Residuals           | 501 | 1398.51 | 2.791   |         |           |
| Lack of fit         | 5   | 22.17   | 4.433   | 1.5976  | 0.1591    |
| Pure error          | 496 | 1376.34 | 2.775   |         |           |

Stationary point of response surface:

| x1         | x2         | x3         | x4        |
|------------|------------|------------|-----------|
| -5.0780791 | -0.2337826 | -0.1494056 | 0.8052855 |

Stationary point in original units:

| Percent.sugar Ratio.yoghurt | Percent.kiwi | Percent.water |
|-----------------------------|--------------|---------------|
| -12.35136                   | 18.42508     | 10.97708      |
|                             |              | 31.95550      |

Eigenanalysis:

\$values

[1] 0.08050972 0.07219787 -0.03345502 -0.11925256

\$vectors

| [,1] | [,2] | [,3] | [,4] |
|------|------|------|------|
|------|------|------|------|

```
[1,] 0.56812513 -0.1151861 0.78027415 0.2348153
[2,] 0.02129433 0.7869654 -0.08320188 0.6109905
[3,] -0.52760775 0.4248998 0.58218652 -0.4496099
[4,] 0.63119763 0.4322936 -0.21285806 -0.6077855
```

```
> design.rs1<-rsm(response~FO(x1,x2,x3,x4),data=design.CR)
> summary(design.rs1)
```

Call:

```
rsm(formula = response ~ FO(x1, x2, x3, x4), data = design.CR)
```

Residuals:

|  | Min    | 1Q     | Median | 3Q    | Max   |
|--|--------|--------|--------|-------|-------|
|  | -5.244 | -1.029 | 0.002  | 1.162 | 3.397 |

Coefficients:

|             | Estimate | Std. Error | t value | Pr(> t )     |
|-------------|----------|------------|---------|--------------|
| (Intercept) | 5.92383  | 0.07412    | 79.919  | < 2e-16 ***  |
| x1          | -0.09570 | 0.07412    | -1.291  | 0.19724      |
| x2          | -0.30273 | 0.07412    | -4.084  | 5.14e-05 *** |
| x3          | -0.21289 | 0.07412    | -2.872  | 0.00425 **   |
| x4          | 0.50586  | 0.07412    | 6.825   | 2.52e-11 *** |

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.677 on 507 degrees of freedom

Multiple R-squared: 0.1261, Adjusted R-squared: 0.1192

F-statistic: 18.29 on 4 and 507 DF, p-value: 4.741e-14

Analysis of Variance Table

Response: response

|                    | Df  | Sum Sq  | Mean Sq | F value | Pr(>F)    |
|--------------------|-----|---------|---------|---------|-----------|
| FO(x1, x2, x3, x4) | 4   | 205.84  | 51.459  | 18.2932 | 4.741e-14 |
| Residuals          | 507 | 1426.19 | 2.813   |         |           |
| Lack of fit        | 11  | 49.85   | 4.532   | 1.6331  | 0.08619   |
| Pure error         | 496 | 1376.34 | 2.775   |         |           |

Direction of steepest ascent (at radius 1):

| x1         | x2         | x3         | x4        |
|------------|------------|------------|-----------|
| -0.1509387 | -0.4774590 | -0.3357615 | 0.7978186 |

Corresponding increment in original units:



|                             |              |               |
|-----------------------------|--------------|---------------|
| Percent.sugar Ratio.yoghurt | Percent.kiwi | Percent.water |
| -0.679224                   | -6.994775    | -1.175165     |
|                             |              | 8.377096      |

```
> design.rs1<-rsm(response~FO(x1,x2,x3,x4)+TWI(x1,x2,x3,x4),data=design.CR)
> summary(design.rs1)
```

Call:

```
rsm(formula = response ~ FO(x1, x2, x3, x4) + TWI(x1, x2, x3,
x4), data = design.CR)
```

Residuals:

| Min     | 1Q      | Median  | 3Q     | Max    |
|---------|---------|---------|--------|--------|
| -5.4668 | -1.1621 | -0.0605 | 1.0957 | 3.3301 |

Coefficients:

|             | Estimate | Std. Error | t value | Pr(> t )     |
|-------------|----------|------------|---------|--------------|
| (Intercept) | 5.92383  | 0.07384    | 80.228  | < 2e-16 ***  |
| x1          | -0.09570 | 0.07384    | -1.296  | 0.19553      |
| x2          | -0.30273 | 0.07384    | -4.100  | 4.82e-05 *** |
| x3          | -0.21289 | 0.07384    | -2.883  | 0.00411 **   |
| x4          | 0.50586  | 0.07384    | 6.851   | 2.16e-11 *** |
| x1:x2       | -0.04102 | 0.07384    | -0.555  | 0.57881      |
| x1:x3       | -0.06055 | 0.07384    | -0.820  | 0.41261      |
| x1:x4       | 0.09570  | 0.07384    | 1.296   | 0.19553      |
| x2:x3       | 0.11523  | 0.07384    | 1.561   | 0.11924      |
| x2:x4       | 0.13867  | 0.07384    | 1.878   | 0.06095 .    |
| x3:x4       | -0.08398 | 0.07384    | -1.137  | 0.25591      |

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.671 on 501 degrees of freedom

Multiple R-squared: 0.1431, Adjusted R-squared: 0.126

F-statistic: 8.366 on 10 and 501 DF, p-value: 1.253e-12

Analysis of Variance Table

Response: response

|                     | Df  | Sum Sq  | Mean Sq | F value | Pr(>F)    |
|---------------------|-----|---------|---------|---------|-----------|
| FO(x1, x2, x3, x4)  | 4   | 205.84  | 51.459  | 18.4346 | 3.823e-14 |
| TWI(x1, x2, x3, x4) | 6   | 27.68   | 4.614   | 1.6529  | 0.1307    |
| Residuals           | 501 | 1398.51 | 2.791   |         |           |
| Lack of fit         | 5   | 22.17   | 4.433   | 1.5976  | 0.1591    |
| Pure error          | 496 | 1376.34 | 2.775   |         |           |

Stationary point of response surface:

| x1         | x2         | x3         | x4        |
|------------|------------|------------|-----------|
| -5.0780791 | -0.2337826 | -0.1494056 | 0.8052855 |

Stationary point in original units:

| Percent.sugar | Ratio.yoghurt | Percent.kiwi | Percent.water |
|---------------|---------------|--------------|---------------|
| -12.35136     | 18.42508      | 10.97708     | 31.95550      |

Eigenanalysis:

\$values

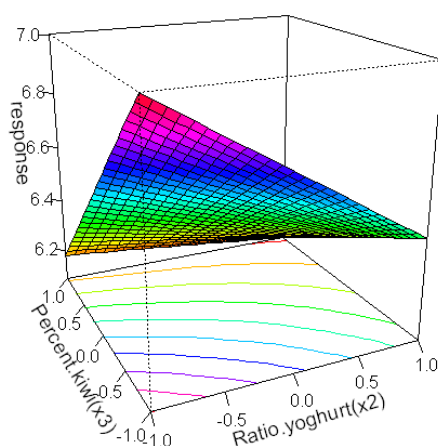
[1] 0.08050972 0.07219787 -0.03345502 -0.11925256

\$vectors

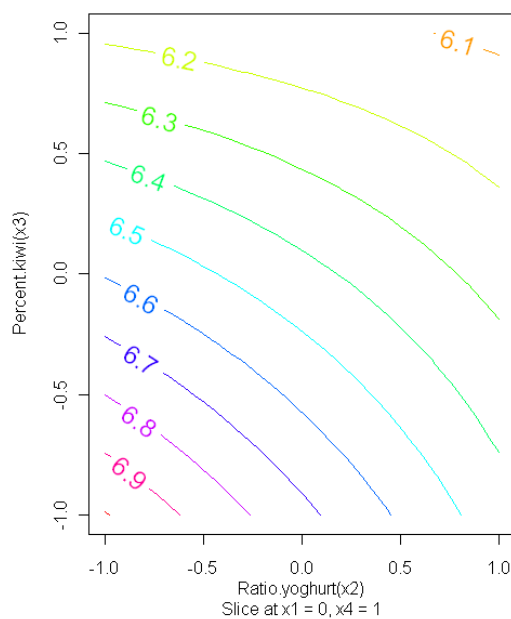
|      | [,1]        | [,2]       | [,3]        | [,4]       |
|------|-------------|------------|-------------|------------|
| [1,] | 0.56812513  | -0.1151861 | 0.78027415  | 0.2348153  |
| [2,] | 0.02129433  | 0.7869654  | -0.08320188 | 0.6109905  |
| [3,] | -0.52760775 | 0.4248998  | 0.58218652  | -0.4496099 |
| [4,] | 0.63119763  | 0.4322936  | -0.21285806 | -0.6077855 |

```
> par(mfrow=c(1,2))
```

```
> persp(design.rs1, ~x2+x3, col=rainbow(50), contours="colors", xlab=c("Ratio.yoghurt(x2)", "Percent.kiwi(x3)"), at=list(x4="1"), zlab="response", cex.lab=1.2)
> contour(design.rs1, ~x2+x3, col=rainbow(10), xlab=c("Ratio.yoghurt(x2)", "Percent.kiwi(x3)"), labce
x=1.5, at=list(x4="1"))
```

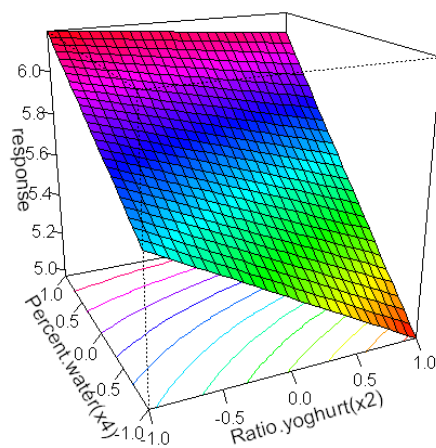


Slice at x1 = 0, x4 = 1

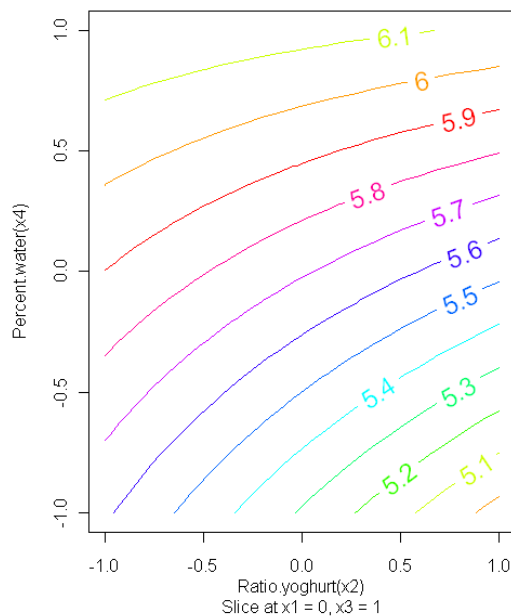


```
> par(mfrow=c(1,2))
```

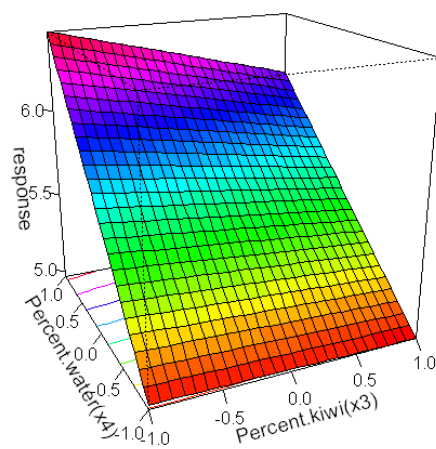
```
>persp(design.rs1,~x2+x4,col=rainbow(50),contours="colors",xlab=c("Ratio.yoghurt(x2)","Percent
.water(x4)"),at=list(x3="1"),zlab="response",cex.lab=1.2)
>contour(design.rs1,~x2+x4,col=rainbow(10),xlab=c("Ratio.yoghurt(x2)","Percent.water(x4)"),labce
x=1.5,at=list(x3="1"))
```



Slice at  $x_1 = 0, x_3 = 1$



```
> par(mfrow=c(1,2))
>persp(design.rs1,~x3+x4,col=rainbow(50),contours="colors",xlab=c("Percent.kiwi(x3)","Percent.
water(x4)"),at=list(x2="1"),zlab="response",cex.lab=1.2)
>contour(design.rs1,~x3+x4,col=rainbow(10),xlab=c("Percent.kiwi(x3)","Percent.water(x4)"),labce
x=1.5,at=list(x2="1"))
```



Slice at  $x_1 = 0, x_2 = 1$

